3-D NEUTRONICS-LINKED HYDRODYNAMICS CALCULATIONS FOR INERTIAL FUSION TARGETS

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Pulsed-power driven inertial confinement fusion (ICF) has shown promising results over the past few years, with the development of intense soft X-ray sources based on wire-array implosion. Neutronics and radiative transport play an important role in determining the evolution of reactor-scale ICF targets. Numerical simulation through partially-coupled one-dimensional hydrodynamic and neutron transport codes has been reported for X-1 targets and light ion fusion LIBRA-SP targets [1-3] for computing neutron transport and hydrodynamic evolution of various types of targets. These studies have two major limitations. Firstly, they are limited to 1-D geometries. Secondly, they do not utilize the energy deposition due to neutron slowing-down in the hydrodynamic calculations, which can be important in reactor-scale pellets.

In the present study, we use a three-dimensional Monte Carlo neutron transport code along with a modified form of the 2-D axisymmetric radiation-hydrodynamics code MULTI-2D [4]. The modified form of Multi-2D uses the Lagrangian approach and allows fairly complex, multi-material geometries. Our calculation starts around the point of peak compression of the ICF target, with pellet parameters taken from Refs.[1-3]. At selected time-points (snap-shots) in the radiation-hydrodynamic simulation, the neutron flux distribution is determined, using the spatial distribution of fusion reaction rate as the source term for neutron transport. The energy deposition arising due to neutron slowing-down is also taken into account.

Apart from snapshots of the neutron flux distribution, the simulation yields the temporal, 2-D evolution of parameters such as the matter and radiation temperatures, density, pressure and the velocity field. It also yields the neutron spectrum emerging at the surface of the pellet, which is useful for comparison with diagnostics.

References

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